1 | Aeronian (Llandovery, Silurian) conodonts from the Densmore Creek Phosphate Bed and the
2 Budd Road Phosphate Bed, Clinton Group, western New York State

3

4 Christopher B. Waid¹ and D. Jeffrey Over²

5

6 ¹ Department of Earth and Environmental Sciences, University of Iowa, 115 Trowbridge Hall,
7 Iowa City, IA 52242. Email: christopher-waid@uiowa.edu

8

9 ² Department of Geological Sciences, State University of New York, College at Geneseo, 1
10 College Circle, Geneseo, NY, 14454. Email: over@geneseo.edu

11

12

13

14

15

16

17

18

19

20

21

22

23

Formatted: Numbering: Continuous

Abstract

Conodonts from the Densmore Creek Phosphate Bed at the base of the Maplewood Shale in Irondequoit, NY, include *Panderodus unicostatus*, *Pranognathus tenuis*, and *Icriodella discreta*. The taxa *Ozarkodina* cf. *Oz. hassi*, *Pranognathus tenuis*, *Oulodus panuarensis*, *Panderodus unicostatus*, *Panderodus recurvatus*, and *Pseudooneotodus beckmanni* were recovered from the overlying Budd Road Phosphate Bed at the base of the Reynales Limestone near Lockport, NY. The specimens from both beds are indicative of the *Pranognathus tenuis* Zone, which correlates to the lower to middle Aeronian, and indicate that the Budd Road Phosphate Bed at Lockport was deposited in a more offshore environment than the Densmore Creek Phosphate Bed at Irondequoit.

Key Words: Llandovery, Conodont, Clinton Group, Biostratigraphy, Appalachian Basin

Introduction

The Maplewood and Neahga shales were deposited in the Appalachian Basin during the early Silurian. The Maplewood extends from central to west-central New York State, and the Neahga extends from western New York State to southern Ontario (LoDuca and Brett 1994). Both units overlie the Densmore Creek Phosphate Bed (DCPB), which overlies the Kodak Sandstone, Cambria Shale, or Thorold Sandstone, depending on geographic location. The Maplewood and Neahga are overlain by the Reynales Limestone, where the lowermost stratum is the Budd Road Phosphate Bed (BRPB; Fig. 1).

The DCPB is a pale olive gray, calcareous, sandy siltstone bearing sand to pebble sized black phosphate nodules. It has been interpreted as a flooding surface lag bed which indicates rapid deepening following the development of an erosional surface which truncated the underlying Medina Group, though the depositional environment remained relatively shallow marine (Brett et al. 1990). The Maplewood Shale and equivalent Neahga Shale were both deposited under shallower marine conditions than the DCPB. The Neahga Shale is a brachiopod and gastropod bearing, greenish gray silty shale, and the Maplewood Shale is a silty light gray shale containing very rare gastropod and brachiopod fossils (LoDuca and Brett 1994). The BRPB is a dark gray to slightly olive gray, shelly, phosphate nodule-bearing biopackstone, and has been interpreted as a lag bed indicating rapid transgression (LoDuca and Brett 1994). Brett et al. (1990) and Hettinger (2001) interpret the DCPB, Maplewood and Neahga shales, and the overlying Reynales Limestone to represent the second Silurian 3rd order sequence recorded in the Appalachian Basin, and the sea-level fluctuations indicated by the DCPB, Maplewood and Neahga shales, and the BRPB to be higher-order cycles superimposed on the 3rd order sequence.

LoDuca and Brett (1994) assigned the Neahga Shale to the Aeronian Stage based on brachiopod and ostracode zonations. They considered the Maplewood to be chronostratigraphically equivalent to the Neahga because they are bounded on the top and bottom by the same units (BRPB and DCPB, respectively). In a field trip guide book, Kleffner (2004) reported that conodont elements diagnostic of the *Distomodus kentuckyensis* Zone were found in the DCPB and Neahga Shale, and conodonts diagnostic of the *Pranognathus tenuis* Zone were found in the Reynales Limestone. The *D. kentuckyensis* Zone ranges from the lowermost Rhuddanian through the middle Aeronian, and the *Pr. tenuis* Zone ranges from the lower to middle Aeronian. This study documents the diverse conodont fauna from the DCPB and BRPB, which confines the Maplewood and Neahga shales to the lower to middle Aeronian and allows regional and global correlation.

Methods

The DCPB was collected at the type locality along the bed of Densmore Creek in Irondequoit, Monroe County, NY. Samples of the Neahga Shale and BRPB were collected at the type locality of the BRPB along Budd Road in Lockport, Niagara County, NY (Fig. 2). Material from the DCPB (1.67 kg) and the BRPB (2.8 kg) were dissolved in 10% formic acid buffered with calcium carbonate and calcium phosphate, and the insoluble residue was recovered on 1.0 and 0.074 mm mesh sieves. 0.5 kg of the Neahga Shale was disaggregated using Calgon water softener, and then washed through 1.0 mm, 0.5 mm, and 0.125 mm sieves. Density separation was performed on the material from the 0.125 and 0.074 mm sieves using lithium metatungstate

92 at a density of 2.85 g/cm³. Photographs of selected specimens were taken using a mounted
93 CANON digital camera and Zerene image stacking software.

94

95 Results and Discussion

96

97 The DCPB was much less soluble in acid than the BRPB; 0.52 kg of the DCPB dissolved
98 after a week in acid, while 2.01 kg of the BRPB dissolved after two days. The Neahga Shale
99 disaggregated very easily in Calgon treatment. 76 conodont specimens were recovered from the
100 DCPB, 343 from the BRPB (Table 1; Fig. 3), and no specimens were recovered from the Neahga
101 Shale. Specimens from the DCPB in Irondequoit had a CAI of 2-2.5, and specimens from the
102 BRPB in Lockport had a CAI of 1.5. Conodonts from the DCPB were more fragmented and
103 worn compared to those from the BRPB.

104 *Panderodus unicostatus*, *Panderodus recurvatus*, *Pr. tenuis*, and *Icriodella discreta* were
105 recovered from the DCPB. *Panderodus unicostatus*, *P. recurvatus*, *Pseudooneotodus beckmanni*,
106 *Ozarkodina cf. Oz. hassi*, *Pr. tenuis*, and *Oulodus panuarensis* were recovered from the BRPB.
107 The DCPB is dominated by *I. discreta*, with rare *P. unicostatus* and *P. recurvatus*. The BRPB
108 has a relatively diverse fauna that is dominated by *P. unicostatus*. Zhang et al. (2002) found that
109 *P. unicostatus* could tolerate both deep and shallow water conditions, but that it was usually
110 associated with deep water environments. It has also been noted that *I. discreta* lived in relatively
111 near shore, relatively high energy environments, and that *Pr. tenuis* lived in lower energy, though
112 still relatively shallow, conditions (Aldridge 2002). This indicates that the DCPB in Irondequoit,
113 NY was deposited in more nearshore, shallow, and slightly higher energy conditions than the
114 BRPB in Lockport, NY. This may indicate higher sea level during the time that the BRPB was
115 deposited relative to the DCPB, or the different faunas of each unit may also be due to lateral

facies variation, since the DCPB and BRPB were collected at localities approximately 100 km apart.

The conodonts found in both the DCPB and the BRPB are representative of the *Pr. tenuis* Zone, which ranges from the first appearance of the nominal species to the first appearance of *Distomodus staurognathoides* (Viira and Männik 1997; Melchin et al. 2012). The first occurrence of *D. staurognathoides* in western New York is in the Lower Sodus Shale, which overlies the Reynales Limestone (Verniers et al. 2012). The correlation of the first appearances of *Pr. tenuis* and *D. staurognathoides* to Aeronian graptolite zones is somewhat unclear, but the most recent data indicate that the *Pr. tenuis* Zone extends from the middle of the *Demirastrites pectinatus* - *D. triangulatus* Zone to the middle of the *Lituigraptus convolutes* - *Monograptus argenteus* Zone (Fig. 4). This indicates that the Maplewood Formation and BRPB should be assigned to Aeronian stage slice 1 or 2 of Cramer et al. (2011).

Taxonomic Notes

The element notation of Purnell et al. (2000) is used in this study. The notation was developed primarily from natural assemblages of ozarkodinid conodonts, but evidence from natural assemblages of less-derived taxa (e.g. *Phragmodus*, *Promissum*) indicate that the notation is likely valid for all prioniodontid conodonts (Purnell et al., 2000; Donoghue et al., 2008). All specimens are stored in the Paleontology Repository, Department of Earth and Environmental Science, University of Iowa.

Genus *Icriodella* Rhodes, 1953

Icriodella discreta Pollock, Rexroad, and Nicoll, 1970

Figs. 3.1-3.7

Description: *I. discreta* has an apparatus consisting of six elements. The S_0 element has a prominent, slightly curved cusp with two symmetrical, denticle-bearing processes extending laterally and downwards from the cusp. Another denticle is located on a small bar caudal to the cusp. The S_1 element is compound cone in shape with three denticulated, asymmetrical processes extending from a prominent central cusp. The S_2 element is similar to the S_1 , but the three processes are more asymmetrical, and the cusp has a more pronounced curve. The M element is cone shaped with a rounded, excavated base. The P_2 element is characterized by a prominent cusp with an excavated, triangular base. The P_1 element has a dorsal blade-like process with three or four denticles and a large cusp, and a ventral platform process with paired nodes.

Remarks: The orientation of the blade relative to the platform can be used to distinguish *Icriodella discreta* from the similar species *Icriodella deflecta*. *Icriodella discreta* has a gentle s-shaped curve between the ventral and dorsal processes, while *I. deflecta* has a sharper angle.

Stratigraphic Range: Rhuddanian through middle Aeronian.

Genus *Panderodus* Ethington, 1959

Panderodus recurvatus Rhodes, 1953

Fig. 3.28

Remarks: The apparatus is composed of eight simple-cone elements. The basal cavity of *P. recurvatus* is large and tapers drastically to the pronounced curve in the middle of the element.

Stratigraphic Range: Llandovery through Lower Devonian

Panderodus unicastatus Branson and Mehl, 1933

Fig. 3.29

Remarks: The *P. unicastatus* apparatus is composed of seven elements, all of which are simple cones. The elements are distinguished by symmetry, the number of furrows, and striations. *P. unicastatus* elements are generally thinner and have a less pronounced curve than *P. recurvatus*, a species which has a similar age range as *P. unicastatus*. The striations on *P. unicastatus* are more pronounced, and the furrows extend the entire length of the cusp, which may not occur in some specimens of *P. recurvatus*. Many more specimens were found in the BRPB than in the DCPB.

Stratigraphic Range: Llandovery through Lochkovian.

Genus *Pranognathus* Männik and Aldridge, 1989

Pranognathus tenuis Aldridge, 1972

Figs. 3.8, 3.9, 3.14-3.20

Description: The S_0 element has two denticulated processes that extend laterally from a central cusp. One or two denticles may also be present rostral to the central cusp. The S_1 element has a prominent central cusp and two denticulated lateral processes which do not extend as far as those on the S_0 element. The $S_3?$ element has a large central cusp with two asymmetrical lateral processes. The angle between the lateral processes and the cusp is greater than the angle in S_1

185 element. The M element has a prominent cusp with three lateral processes. Two processes have
186 well-defined denticles, while the other may have weakly defined, or none. The P₃ element is
187 pyramid shaped, with three processes extending downwards and away from a prominent, very
188 slightly curved, cusp. The P₂ element has two long processes and two short processes that extend
189 laterally from a prominent central cusp. The P₁ element has five denticulated processes that
190 extend from a minor central cusp. The ventral and dorsal processes form a relatively straight
191 blade, with two processes extending from the caudal side, and another process extending from
192 the dorsal side. The dorsal and two caudal processes are connected by a platform without
193 denticulation. All of the P elements have highly excavated basal cavities.

194 Remarks: All of the specimens from the DCPB were poorly preserved, but the important
195 diagnostic features of the P₁ and P₂ elements were visible. Two specimens similar to the Sc₂
196 element of Männik and Aldridge (1989) were recovered. They are tentatively assigned as S₃,
197 because the angle between the directions that the cusp and denticles point is smaller than that of
198 the Sc₂ element of Männik and Aldridge (1989). No specimens similar to the two elements
199 Aldridge (2002) proposed as occupying the Pd (= P₄) position were found in the DCPB or
200 BRPB.

201 Stratigraphic Range: lower to middle Aeronian.

202
203 Genus *Pseudooneotodus* Drygant, 1974

204 *Pseudooneotodus beckmanni* Bischoff and Sannemann, 1958

205 Fig. 3.27
206
207

208
209 Remarks: *Ps. beckmanni* is distinguished from other species of *Pseudooneotodus* by the shape of
210 the basal cavity and the number of apical tips where *Ps. beckmanni* has one apical tip and a
211 slightly triangular basal cavity.

212 Stratigraphic Range: Upper Ordovician? through Lower Devonian

213
214 Genus *Ozarkodina* Branson and Mehl, 1933

215 *Ozarkodina* cf. *Oz. hassi*

216 Fig. 3.10-3.13

217
218 Description: The S₁ element has a prominent central cusp with two asymmetrical denticulated
219 processes that curve at different angles down from the cusp. The S₂ element has a prominent
220 cusp with two asymmetrical lateral processes. The cusp forms an approximate 90 degree angle
221 with one lateral process, while the other processes curve downward away from the cusp. The P₂
222 element has a prominent cusp with two processes of different lengths. The posterior process is
223 shorter than the anterior, and the anterior processes may curve slightly away from the cusp.
224 There is a moderate basal flare, which is most pronounced under the cusp, and the basal cavity is
225 slightly excavated along the length of the entire element. Aside from the central cusp, the
226 denticles on each process are fairly evenly sized, and grooves separating each denticle are
227 basally confluent, forming a line along the element. The P₁ element is slightly curved with a
228 small cusp on most of the specimens. There is a small basal flare underneath the cusp, but it does
229 not extend along the length of the entire element. The cusp and dorsal denticles are roughly the

230 same size, and the denticles ventral to the cusp are usually smaller. As with the P_2 element, the
231 grooves separating each denticle are basally confluent.

232 Remarks: The P_2 elements are not as robust as those recorded by McCracken and Barnes (1981)
233 and Zhang and Barnes (2002). Unlike the holo- and paratype specimens of the P_1 element
234 (Pollock, Rexroad, and Nicoll, 1970, pl. 111, fig. 8-12), the processes dorsal to the cusp are
235 curved down, giving the element a slightly curved shape in lateral view.

236 Stratigraphic Range: lower to middle Aeronian

237

238 Genus *Oulodus* Branson and Mehl, 1933

239 *Oulodus panuarensis* Bischoff, 1986

240 Fig. 3.21-3.26

241

242 Description: The P_1 element has two curved and slightly arched processes that form an angle of
243 approximately 120 degrees. Cusp and denticles on dorsal process are reclined. Denticles are peg-
244 like and round in cross section. The basal cavity is expanded beneath the cusp, and extends to the
245 dorsal and ventral ends of the element. P_2 element is composed of two slightly arched processes.
246 Processes do not curve as much as those on the P_1 elements, giving it a more symmetrical shape.
247 The denticles are round in cross section, and do not curve dorsally like those on the P_1 elements.
248 The basal cavity is expanded underneath the cusp, and extends along both processes. The S_0
249 element has a prominent, curved cusp with two symmetrical, denticle-bearing processes. The S_1
250 element is similar to the S_0 , but each process curves away from the cusp at slightly different
251 angles. The S_2 element has a prominent cusp with two denticle-bearing, very asymmetrical,

processes. The cusp curves over the caudal process. The M element consists of a curved cusp with a lateral process with inclined denticles.

Remarks: The emended diagnosis of Zhang and Barnes (2002) is used. The basal cavities under the cusps of the P₁ and P₂ elements are slightly less expanded than those recorded in Zhang and Barnes (2002).

Stratigraphic Range: Rhuddanian through upper Aeronian.

Summary

The conodonts from both the Densmore Creek Phosphate Bed of the Maplewood Shale and the Budd Road Phosphate Bed of the Reynales Formation are indicative of the *Pranognathus tenuis* Zone, which correlates to the lower to middle Aeronian. The fauna from the Densmore Creek Phosphate Bed in Irondequoit was dominated by *Icriodella discreta*, which indicates that it was deposited in a near shore and moderate-energy environment. The Budd Road Phosphate Bed in Lockport yielded a diverse fauna containing *Pranognathus tenuis* and dominated by *Panderodus unicostatus*, which indicates that it was deposited under deeper water and lower energy conditions than the Densmore Creek Phosphate Bed.

Acknowledgements

We would like to thank Nicholas Hogancamp for assisting with sample collection, Alyssa Bancroft for helping photograph the specimens, and Jonathan Adrain and Bradley Cramer for the use of photography equipment and conodont processing materials at the University of Iowa. The

275 thoughtful and thorough reviews of C.E. Brett and M.A. Kleffner helped improve the quality of
276 this manuscript, and their effort is greatly appreciated. Funding was provided by the Geneseo
277 Student Association and the Geneseo Foundation.

278

279 References

280

281 Aldridge, R. 1972. Llandovery conodonts from the Welsh Borderland; Bulletin of the British
282 Museum, **22**(2):127-266.

283 Aldridge, R. 2002. Conodonts from the Skomer Volcanic Group (Llandovery Series, Silurian) of
284 Pembrokeshire, Wales. Special Papers in Paleontology, **67**: 15-28.

285 Bischoff, G. 1986. Early and Middle Silurian conodonts from midwestern New South Wales.
286 Courier Forschungsinstitut Senckenberg, **89**: 337p.

287 Bischoff, G., and Sannemann, D. 1958. Unterdevonische Conodonten aus dem Frankenwald.
288 Notizblatt des hessisches Landesamt für Bodenforschung zu Wiesbaden, **86**: 87-110.

289 Blakey, R. 2013. Paleogeography and regional geologic evolution of North America, Colorado
290 Plateau Geosystems, Inc TM [online]. Available from
291 <https://www2.nau.edu/rcb7/nam.html> [cited 14 August 2015].

292 Branson, E., and Mehl, M. 1933. Conodonts from the Maquoketa-Thebes (Upper Ordovician) of
293 Missouri. The University of Missouri Studies **8**: 121-131.

294 Brett, C., Goodman, W., LoDuca, S. 1990. Sequences, cycles, and basin dynamics in the Silurian
295 of the Appalachian Foreland Basin. Sedimentary Geology, **69**: 191-244.

296 Cramer, B., Kleffner, M., Brett, C., McLaughlin, P., Jeppsson, L., Munnecke, A., Samtleben, C.

2010. Paleobiogeography, high-resolution stratigraphy, and the future of Paleozoic
biostratigraphy: Fine-scale diachroneity of the Wenlock (Silurian) conodont *Kockelella*
walliseri. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **294**(3-4):232-241.

Cramer, B., Brett, C., Melchin, M., Männik, P., Kleffner, M., McLaughlin, P., Loydell, D.,
Munnecke, A., Jeppsson, L., Corradini, C., Brunton, F., and Saltzman, M. 2011. Revised
correlation of Silurian Provincial Series of North America with global and regional
chronostratigraphic units and $\delta^{13}\text{C}_{\text{carb}}$ chemostratigraphy. *Lethaia*, **44**: 185-202.

Donoghue, P., Purnell, M., Aldridge, R., Zhang, S. 2008. The interrelationships of ‘complex’
conodonts (Vertebrata). *Journal of Systematic Paleontology*, **6**(2): 119-153.

Drygant, D. 1974. Prostye konodonty silura I nizov devona Volyno- Podol’ya [Simple conodonts
from the Silurian and lowermost Devonian of Volyno-Podolia]. *Palaeontologicheskij*
Sbornik, **10**: 64-70.

Ethington, R. 1959. Conodonts of the Ordovician Galena Formation. *Journal of Paleontology*,
33: 257-292.

Hettinger, R. 2001. Subsurface correlations and sequence stratigraphic interpretations of Lower
Silurian Strata in the Appalachian Basin of northeast Ohio, southwest New York, and
northwest Pennsylvania. *USGS Geological Investigations Series I-2741*: 1-19.

Kleffner, M. 2004. Lower Silurian Medina and Clinton Groups of the Niagara region. *Geological*
Association of Canada – Mineralogical Association of Canada Meeting 2004, Brock
University, St. Catharines, Ontario – Pander Society Field Trip: 1-5.

LoDuca, S. and Brett, C. 1994. Revised stratigraphic and facies relationships of the lower part of
the Clinton Group (Middle Llandoveryan) of western New York State. *New York State*
Museum Bulletin 481: 161-182.

- 320 Männik, P., Aldridge, R. 1989. Evolution, taxonomy, and relationships of the Silurian conodont
321 *Pterospathodus*. *Paleontology*, **32**(4): 893-906.
- 322 McCracken, A., and Barnes, C. 1981. Conodont biostratigraphy and paleoecology of the Ellis
323 Bay Formation, Anticosti Island, Quebec, with special reference to Late Ordovician-
324 Early Silurian chronostratigraphy and the systematic boundary; Geological Survey of
325 Canada Bulletin 329: 51-133.
- 326 Melchin, M., Sadler, P., & Cramer, B. 2012. Chapter 21: The Silurian Period. *In* The Geologic
327 Time Scale 2012. *Edited by* F. Gradstein, J. Ogg, M. Schmitz, and G. Ogg. Elsevier, New
328 York, New York. pp. 525-558.
- 329 Pollock, C., Rexroad, C., Nicoll, R., 1970. Lower Silurian conodonts from northern Michigan
330 and Ontario. *Journal of Paleontology*, **44**(4): 743-764.
- 331 Purnell, M., Donoghue, P., Aldridge, R. 2000. Orientation and anatomical notation in conodonts.
332 *Journal of Paleontology*, **74**(1): 113-122.
- 333 Rhodes, F. 1953. Some British lower Paleozoic conodont faunas. *Philosophical Transactions of*
334 *the Royal Society, Series B*, **237**: 261-234.
- 335 Verniers, J., Van de Moortel, I., Steeman, T., Mortier, J., Vandenbroucke, T., Cramer, B., Brett,
336 C., Kleffner, M. 2012. The Tryon Park controversy: a combined chitinozoan and
337 conodont restudy. *In* IGCP 591 annual meeting. *Edited by* B. Cramer and C. Brett.
338 Cincinnati, Ohio.
- 339 Viira, V. and Männik, P. 1997. Conodonts. *In* *Geology and Mineral Resources of Estonia. Edited*
340 *by* A. Raukas and A. Teedumäe. Estonian Academy Publishers, Tallinn, Estonia. pp.
341 241-244.
- 342 Zhang, S. and Barnes, C. 2002. A new Llandovery (Early Silurian) conodont biozonation and

343 conodonts from the Becscie, Merrimack, and Gun River Formations, Anticosti Island,
344 Québec. Journal of Paleontology, **76**(sp57): 1-46.

345 Zhang, S., Barnes, C., Pohler, S. 2002. Relationships between lithofacies belts and conodont
346 faunas, Gun River Formation (Lower Silurian), Anticosti Island, Quebec: a statistical
347 approach. Canadian Journal of Earth Science, **39**: 1767-1782.

Draft

Table 1: Conodont specimens from the Densmore Creek Phosphate Bed and Budd Road Phosphate Bed

Densmore Creek Phosphate Bed

Element	P ₁	P ₂	P ₃	M	S ₀	S ₁	S ₂	S ₃	unassigned
<i>I. discreta</i>	20	5	n/a	12	2	3	8	n/a	4
<i>Pr. tenuis</i>	1	5	0	1	0	0	0	0	3
<i>P. unicostatus</i>	*	*	*	*	*	*	*	*	10
<i>P. recurvatus</i>	*	*	*	*	*	*	*	*	2

Budd Road Phosphate Bed

Element	P ₁	P ₂	P ₃	M	S ₀	S ₁	S ₂	S ₃	unassigned
<i>Pr. tenuis</i>	57	32	5	11	3	5	0	2	4
<i>Oz.cf. Oz. hassi</i>	45	6	n/a	0	0	7	6	0	2
<i>Ou. panuarensis</i>	2	4	n/a	2	6	2	5	n/a	2
<i>P. unicostatus</i>	*	*	*	*	*	*	*	*	111
<i>P. recurvatus</i>	*	*	*	*	*	*	*	*	24
<i>Ps. Beckmanni</i>	*	*	*	*	*	*	*	*	2

Simplified cross section and chronostratigraphic diagram of the Medina and "lower Clinton" groups from west to east. Modified from Loduca and Brett (1994).
75x62mm (220 x 220 DPI)

Paleogeographic map showing the location of the continents during the Llandovery, and the northern extent of the Appalachian Basin and sample localities (inset). Shaded box on Laurentia indicates approximate location of Appalachian Basin. Gray shaded area on inset map represents Appalachian Basin. Locality 1: Type section of the BRPB, along Budd Road in Lockport, NY (43.1846° N, 78.7803° W). Locality 2: Type section of the DCPB, along Densmore Creek in Irondequoit, NY (43.1905° N, 77.5493° W). Global map after Cramer et al. (2010). Extent of northern Appalachian Basin after Blakey (2013).
87x57mm (220 x 220 DPI)

Conodonts from the DCPB (1-9) and BRPB (10-29). **1-7.** *Icriodella discreta*. 1, oral view of P_1 element, SUI 141769; 2, lateral view of M element, SUI 141770; 3, caudal view, S_0 element, SUI 141771; 4, caudal view, S_1 element, SUI 141772; 5, lateral view, P_1 element, SUI 141773; 6, oblique-lateral view of S_2 element, SUI 141774; 7, oblique-lateral view of P_2 element, SUI 141775. **8, 9.** *Pranognathus tenuis*. 8, oral view of P_1 element, SUI 141776; 9, upper view of P_2 element, SUI 141777. **10-13.** *Ozarkodina* cf. *Oz. hassi*. 10, lateral view of S_1 element, SUI 141778; 11, oblique-posterior view of S_2 element, SUI 141779; 12, lateral view of P_2 element, SUI 141780; 13, lateral view P_1 element, SUI 141781. **14-20.** *Pranognathus tenuis*. 14, caudal view of S_0 element, SUI 141782; 15, caudal view of S_1 element, SUI 141783; 16, oblique posterior view of $S_3?$ element, SUI 141784; 17, lateral view of M element, SUI 141785; 18, oral view of P_1 element, SUI 141786; 19, oral view of P_2 element, SUI 141787; 20, oral view of P_3 element, SUI 141788. **21-26.** *Oulodus panuaensis*. 21, lateral view of M element, SUI 141789; 22, dorsal view of P_1 element, SUI 141790; 23, dorsal view of P_2 element, SUI 141791; 24, oral-caudal view of S_0 element, SUI 141792; 25, oblique caudal view of S_1 element, SUI 141793; 26, lateral view of S_2 element, SUI 141794. **27.**

Psuedooneotodus beckmanni. Upper view, SUI 141797. **28.** *Panderodus unicostatus*. Lateral view, SUI 141795. **29.** *Panderodus recurvatus*. Lateral view, SUI 141796.
165x213mm (220 x 220 DPI)

Draft